



# IEA SHC Task 62 – Solar energy in industrial water and wastewater management

## Workshop: IEA Solar Heating and Cooling Research Co-operation

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# IEA SHC Task 62 - Solar energy in industrial water & wastewater management



# Background

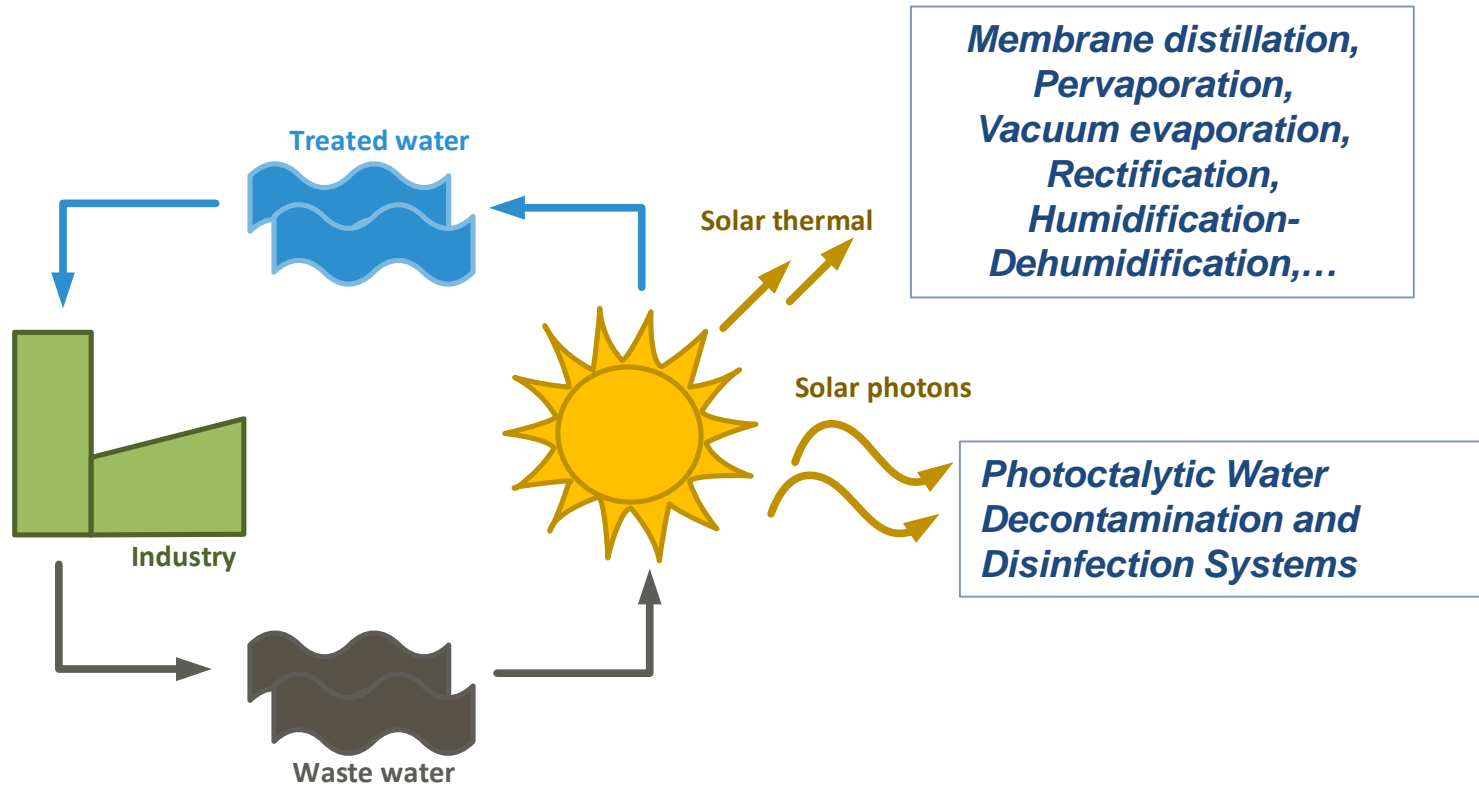


- Industry and agriculture is the largest **water** consuming sector AND **energy** consuming sector (OECD, IEA, 2016) (Eurostat, 2018)
- Change to a **sustainable, resource- and energy-efficient** industry will be the major challenge
- Almost **10%** of global **water withdrawals** in 2014 were for industry (OECD, IEA, 2016)
- Most of it becomes waste water and must be treated before being disposed which causes high **disposal costs** and **resource losses** for industry
- Use of solar process heat represents a **large**, but far largely unused **potential** in industry
- **Solar process heat to supply** technologies for **waste water treatment** presents a new field of application

# Purpose of Task 62

- Reduce the water and energy demand (CO<sub>2</sub> emissions) in industry (process water) and water purification plants (communal and industrial)
- By improving the conditions and increasing the applications of **solar driven separation and water purification technologies in industrial applications** in order
  - to push the solar water treatment market,
  - solve water problems at locations with abundant solar energy resources and
  - reduce the fossil-fuel consumption
- **Combining experts:** Solar turn key provider, water technology sector (e.g. membrane producer,...), engineering companies and producing industry

# Scope of the Task



# Task 62 NEXUS

## Solar energy – water – industry



**Integration concepts**

**Guideline for stakeholders**

**Energy and CO<sub>2</sub> savings**

**Emerging technologies**

**Decontamination and disinfection**

**Recycling of valuable resources**

**New solar collector concepts**

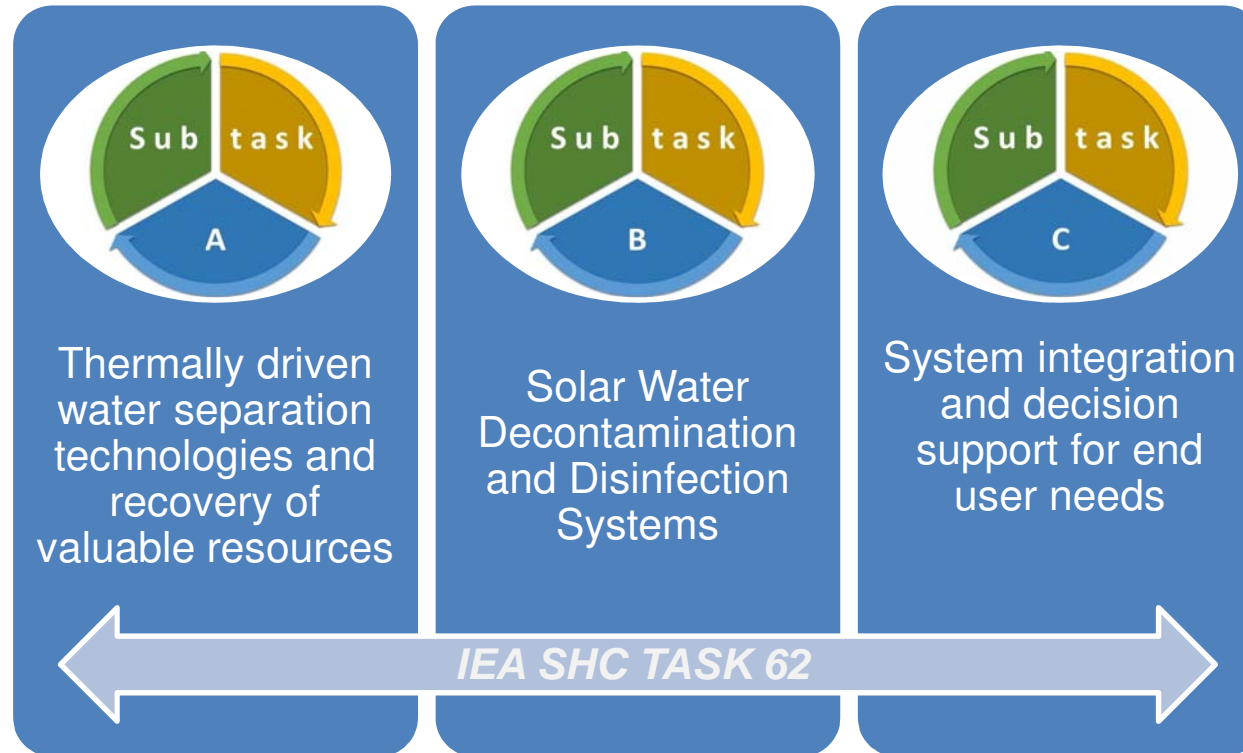
**Link to solar collector suppliers**

**New markets and market penetration**

**Water separation technologies**

**IEA SHC Task 62**

# Subtasks



## Subtasks

### leader

*Joachim Koschikowski, Germany F-ISE*



*Isabel Oller, Spain CIEMAT*



*Mikel Duke, Australia Victoria University*

## SUBTASK A

# Thermally driven water separation technologies and recovery of valuable resources



Source: F-ISE



## Subtask A - Core Activities

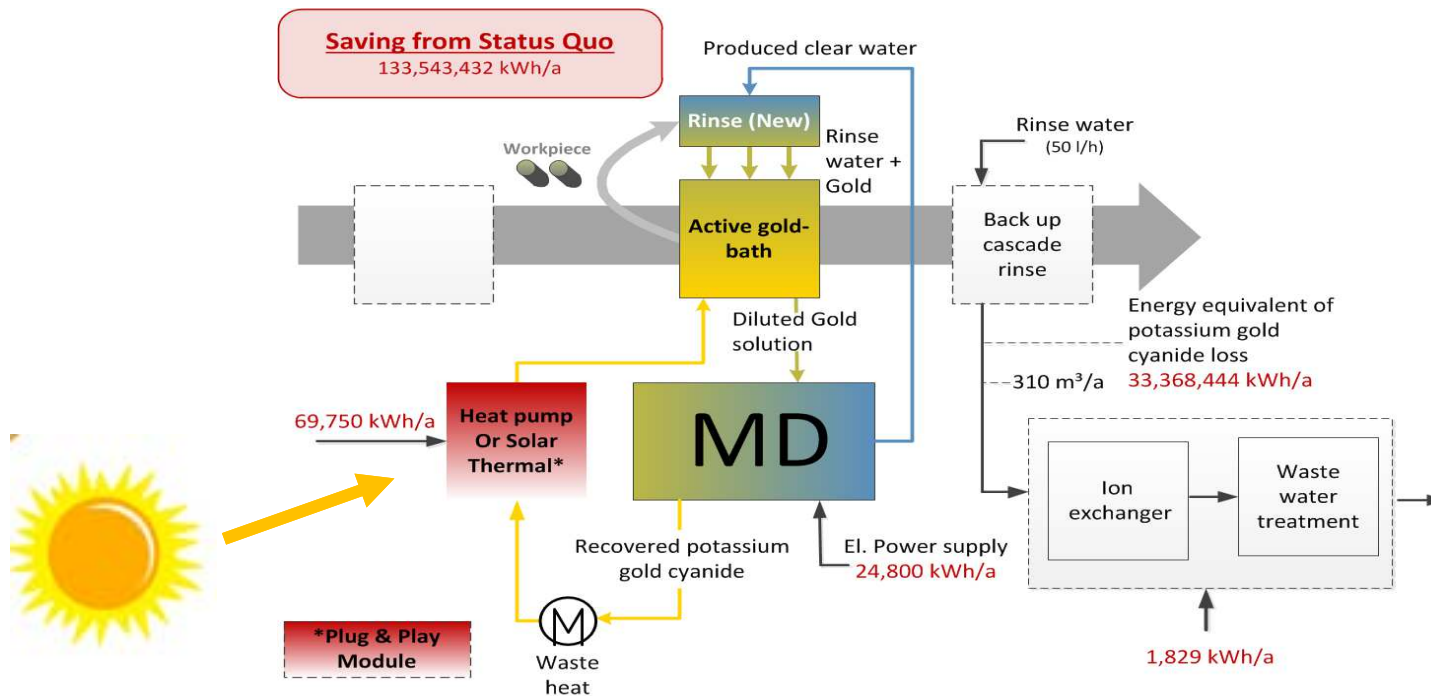


- Identification of separation technologies with high potential for solar thermal heat supply e.g.:
  - Membrane distillation, Pervaporation, Vacuum evaporation, Rectification, Humidification-Dehumidification, Collector integrated systems
- Identification of suitable fields of application (industrial sectors, processes, geographical sites...)
- Assessment of pro and cons of these technologies for different industrial applications and boundary conditions and comparison with state of the art technologies

# Subtask A - Examples / Projects



- H2020 project “*ReWaCEM*”
  - MD for recovery of **gold** and **palladium** streams
  - Membrane distillation as low-ex separation technology for recycling valuables from process baths in printed circuit board - PCB industry





# Demonstration plant at AT&S Austria AG



## Printed circuit boards for:

- Automotive Industry
- medical technology
- aircraft construction
- Mobile Devices & Substrates



Production sites in Austria, Indien, China und South Korea

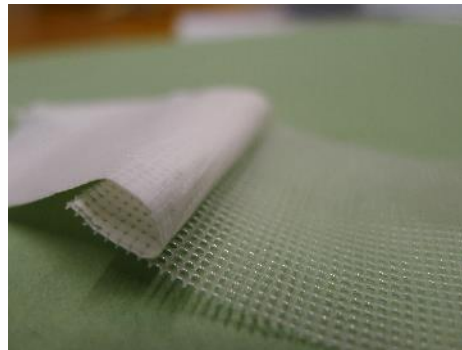


# What is Membrane Distillation?

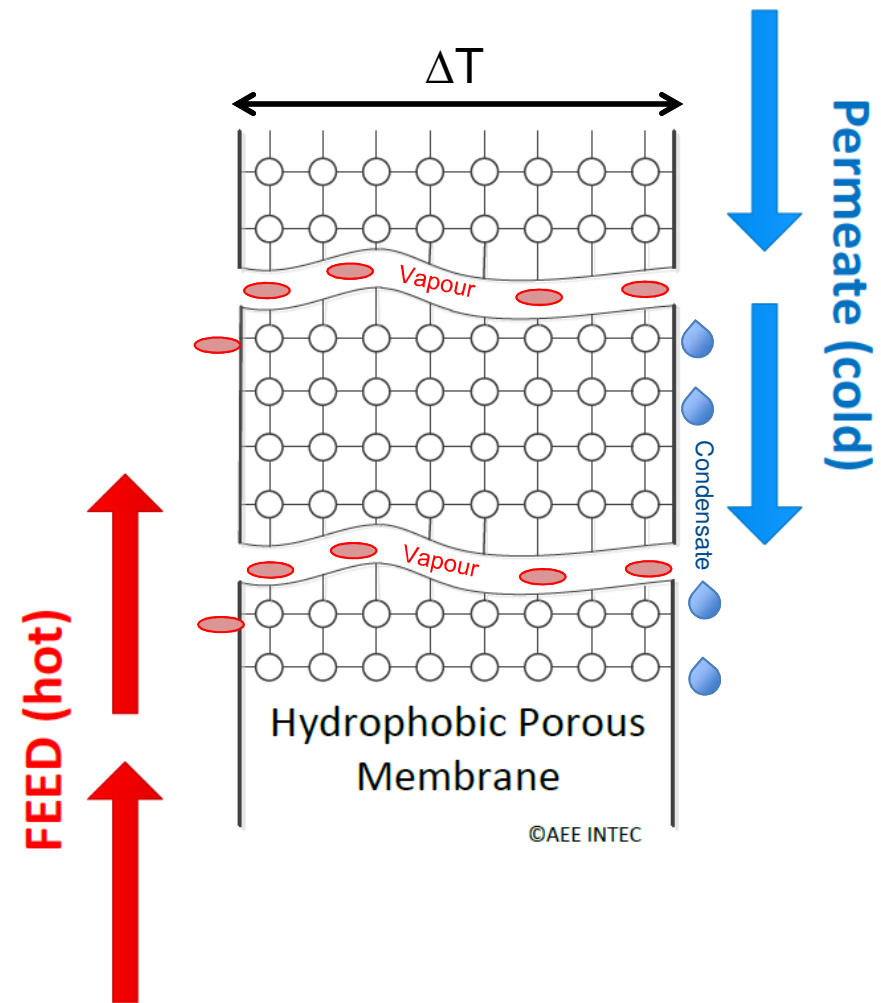


## Thermal separation process

- For separating vaporous molecules from liquids
- Driving force: **Vapour Pressure Difference** (temperature difference  $\Delta T$  between **Feed** and **Permeate**)
- Atmospheric pressure



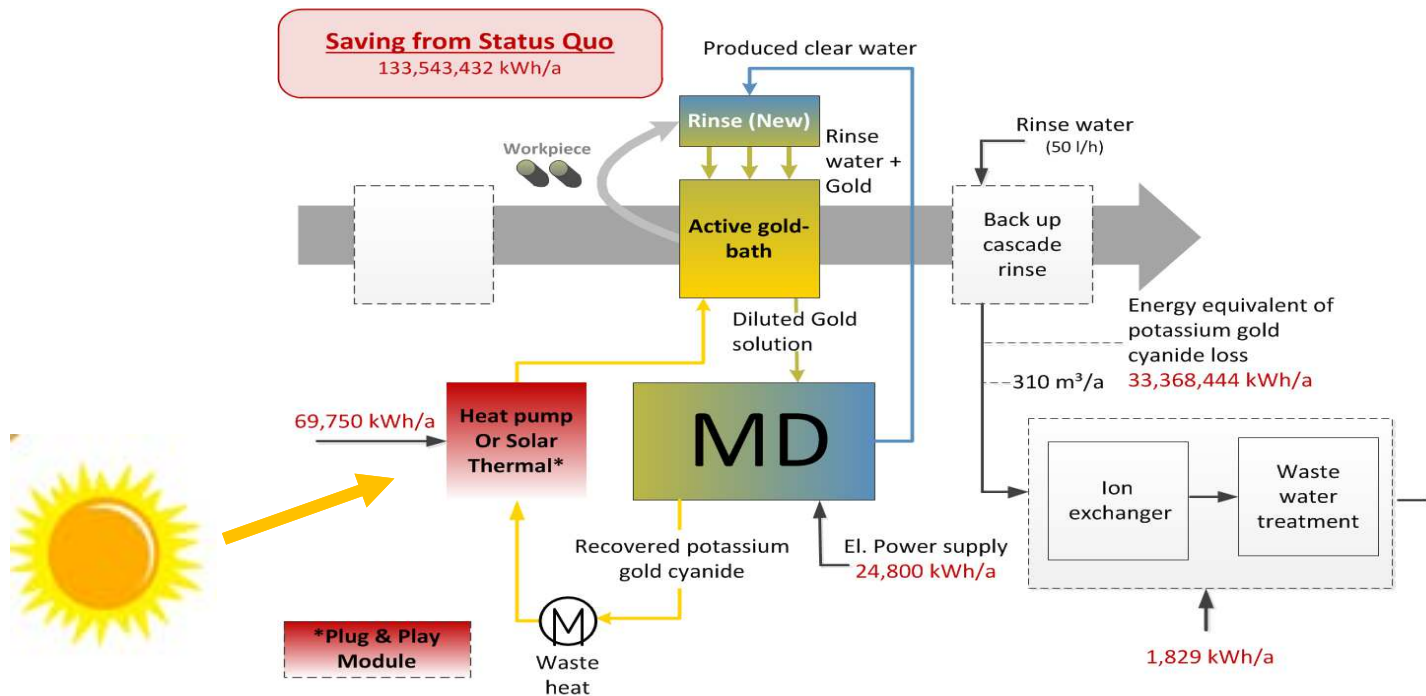
[1] <http://www.campz.de/gore-tex.html>



# Subtask A - Examples / Projects



- H2020 project “*ReWaCEM*”
  - MD for recovery of **gold** and **palladium** streams
  - Membrane distillation as low-ex separation technology for recycling valuables from process baths in printed circuit board - PCB industry



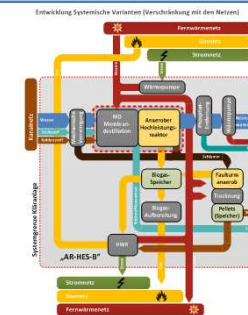
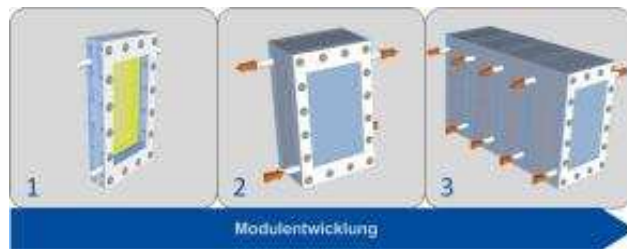
# Main steps



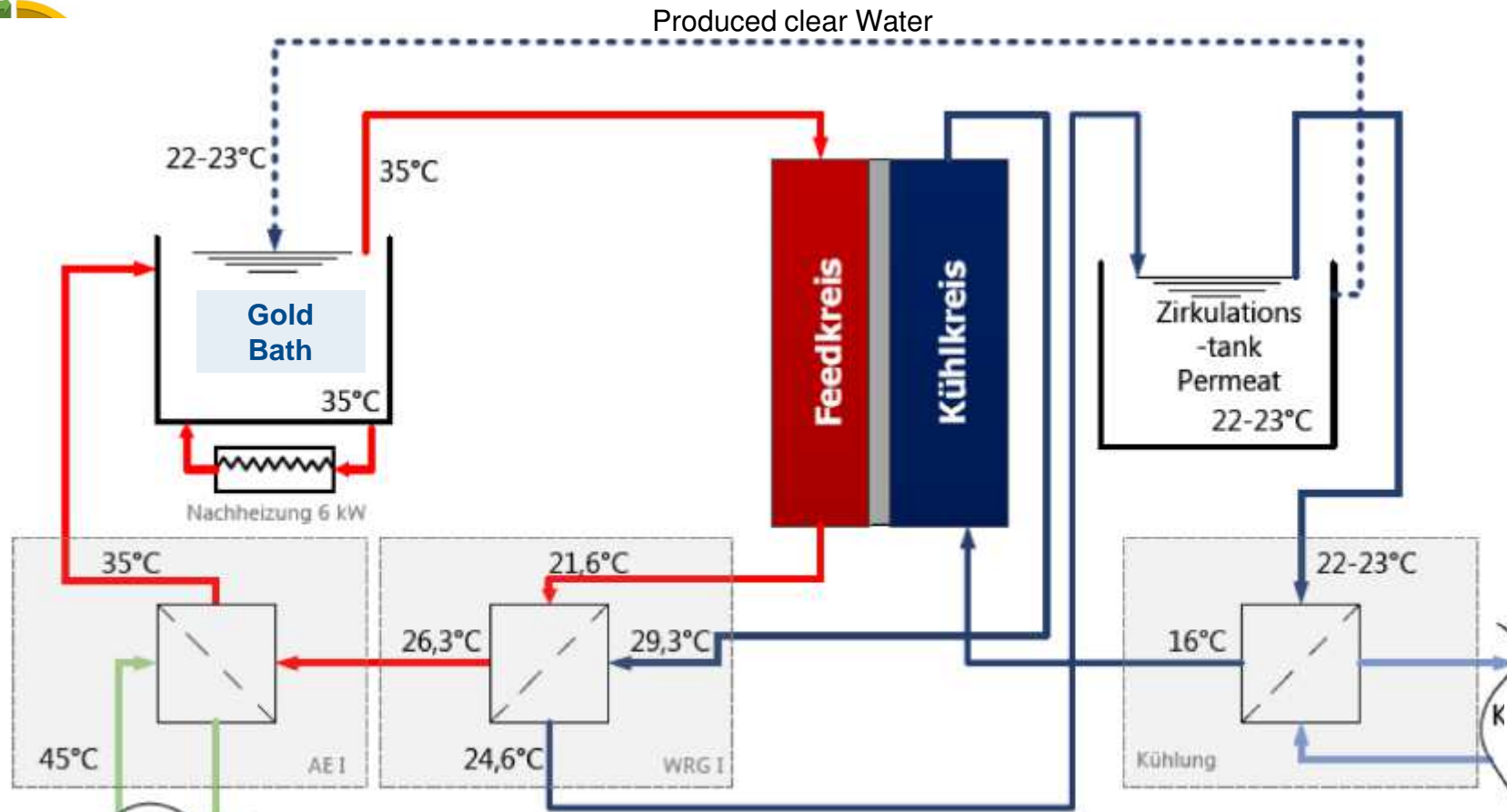
Module design

Plant engineering

System integration



# System integration and energy concept

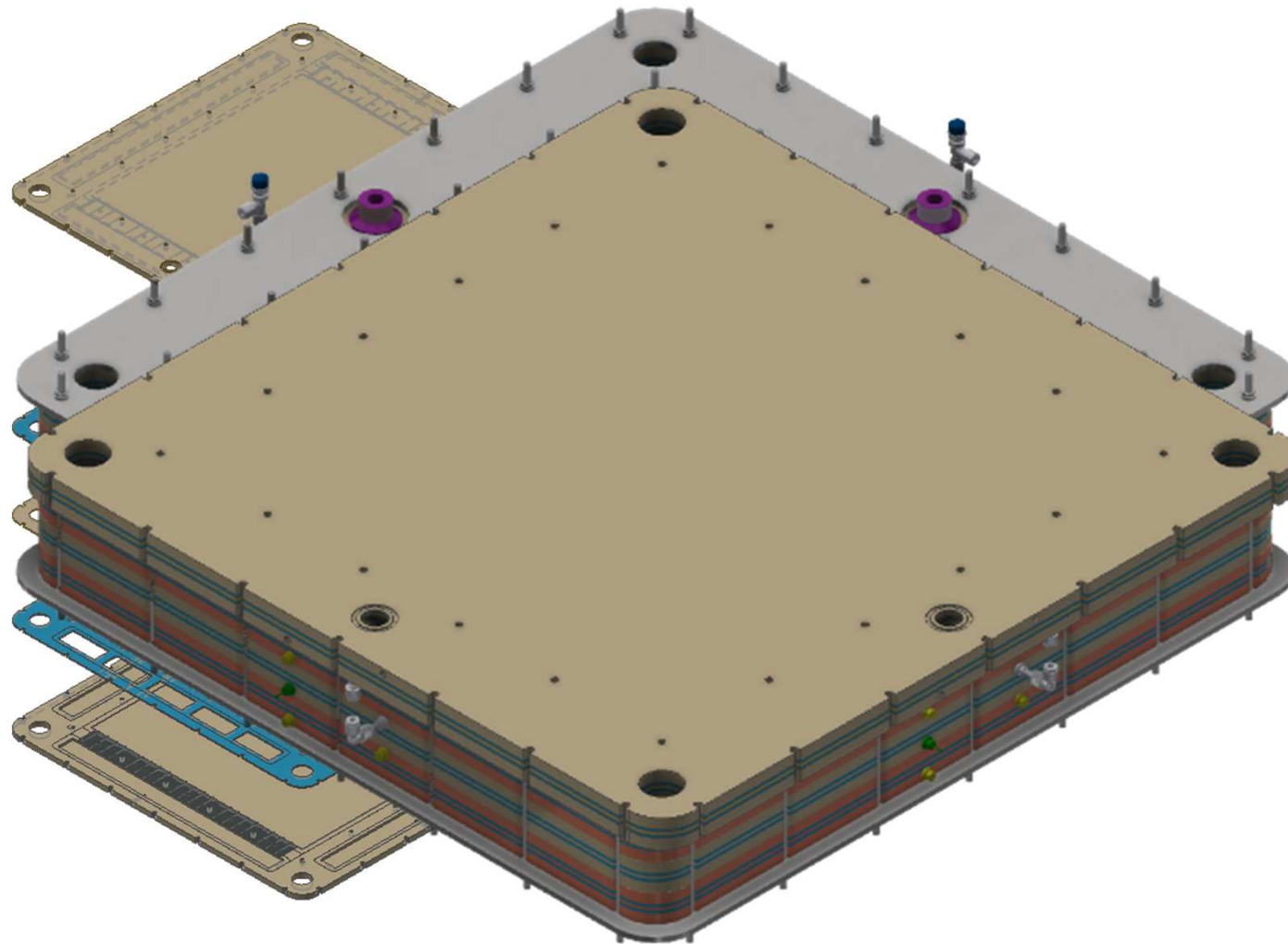


Waste Heat from cooling and Solar thermal energy

MD-Internal Heat Recovery

Cooling (Tap Water Preheating)

# MD module design for AT&S *„Product design“*





# Plant realisation

**MD-plant**  
AT&S Fehring (Styria, Austria)

IEA SHC Task 62



3-D Planning  
MD plant for gold

*Installation April 2019*



## “Gold Case”

- **Yearly cost reduction EUR 149,500.-**
- **Waste water reduction of approx. 1,450 m<sup>3</sup> / a**

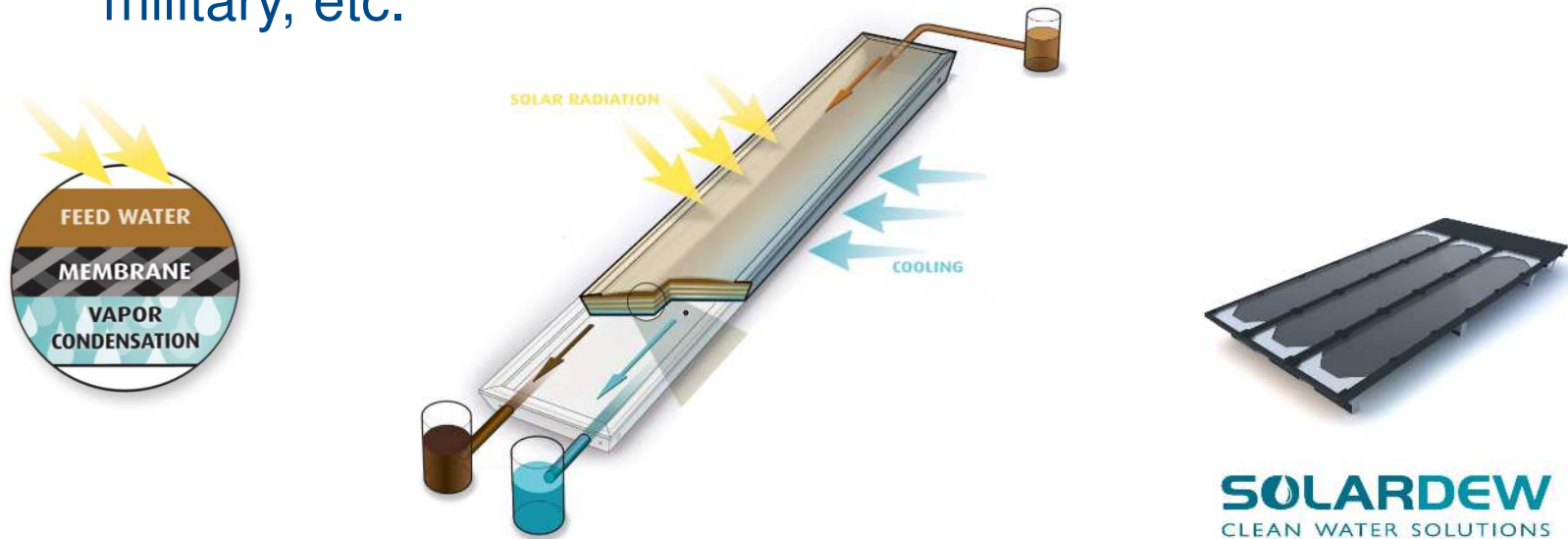


reduction of potassium-gold-cyanide waste water by ~ **80%**

# Subtask A - Examples / Projects



- Company SOLARDEW
  - Small scale desalination
  - New solution for producing drinking water from virtually any source of polluted, contaminated or saline water by utilizing solar radiation and the use of a MD process
  - Main markets include developing countries, emergency relief (e.g. in case of natural disasters), military, etc.



## SUBTASK B

# Solar Water Decontamination and Disinfection Systems



Source: CIEMAT



## Subtask B - Core Activities



- Comprehensive description of the state-of-the-art and potential applications of **solar water decontamination and disinfection systems** in industrial water management
- **Membrane solar photocatalytic systems** for industrial wastewater treatment and reuse.
- Design of **new solar collectors** for industrial wastewater decontamination and disinfection for reusing purposes
- Integration of water decontamination and disinfection technologies driven with solar energy with membrane separation technologies **for recovery of nutrients and products/wastes with added value.**

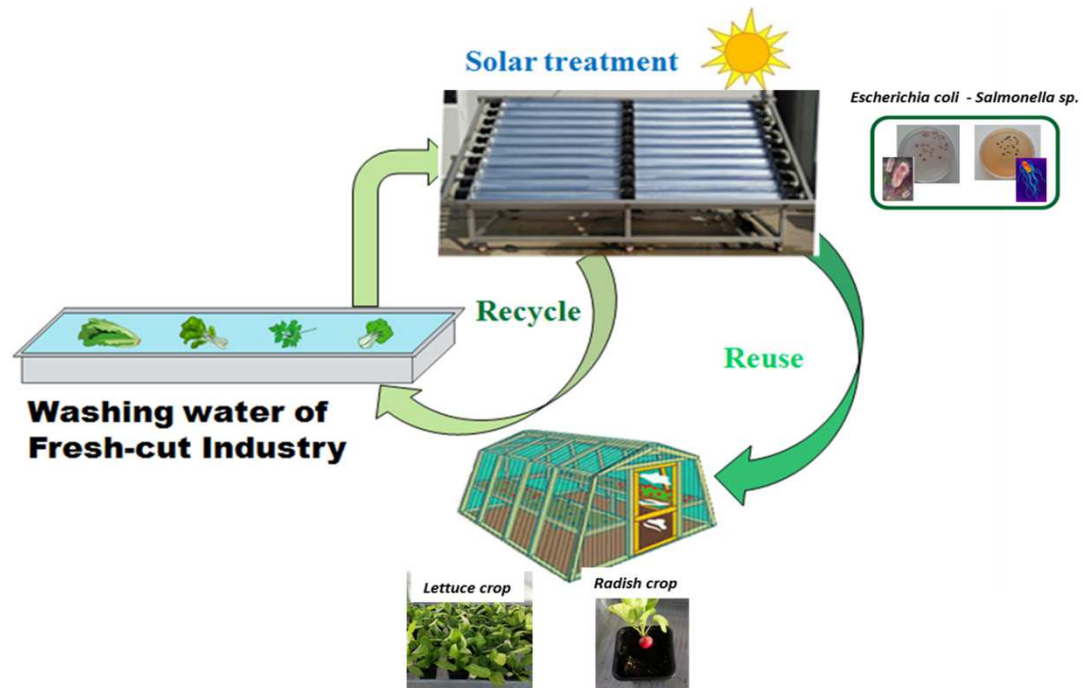
# Subtask B - Examples / Projects



- National spanish project „*Water4Food*“
  - Implementation of a solar process for the treatment of waste water from the production of cut fresh products using innovative oxidation processes in a pilot plant of PSA for forther use for the irrigation of raw vegetables



Source: CIEMAT





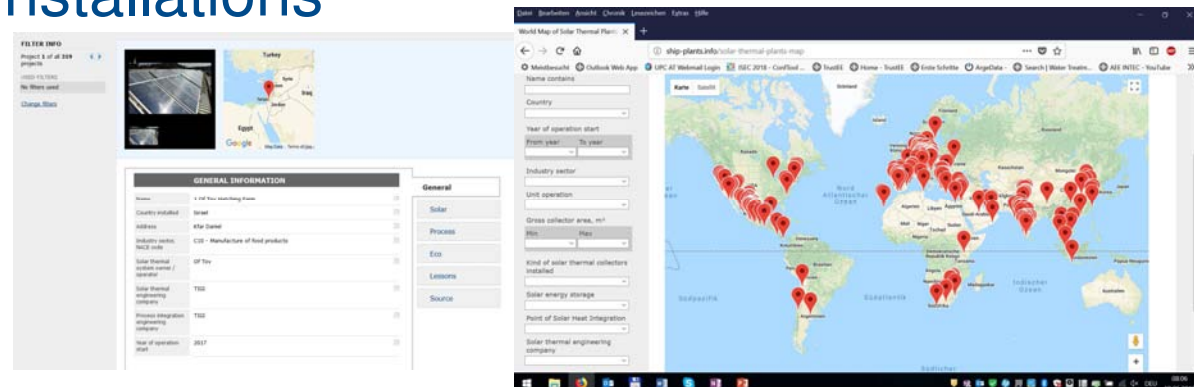
## SUBTASK C

System integrations and decision support for end user needs

# Subtask C - Core activities



- System integrations concepts of solar thermal energy separation technologies – development of **decision support guidelines** for technology end users
- Role of SHIP and water separation in combination with other technologies/energy sources (e.g. reverse osmosis, heat pumps, fossil fuel, biomass, biogas, PV, excess heat)
- Development of additional sector in [SHIP Database](#) of realized installations

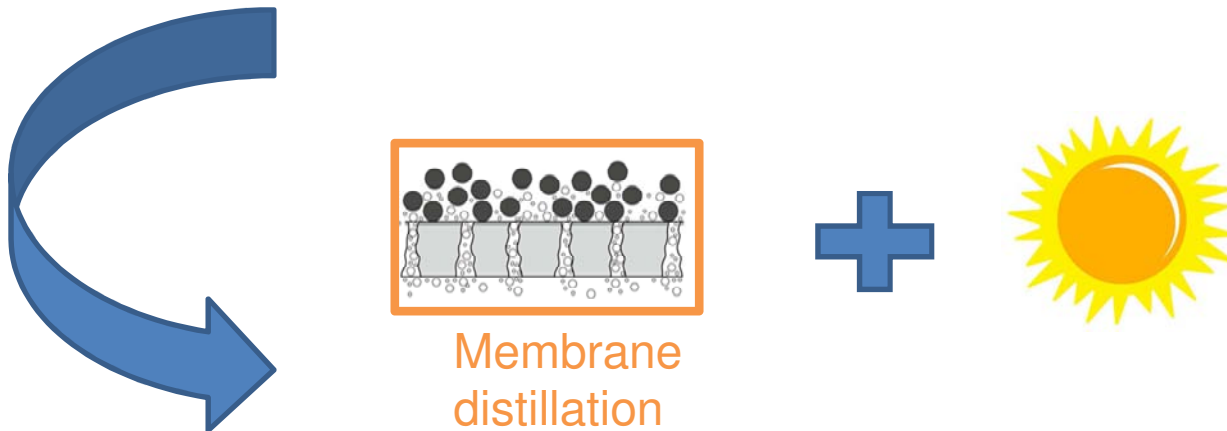




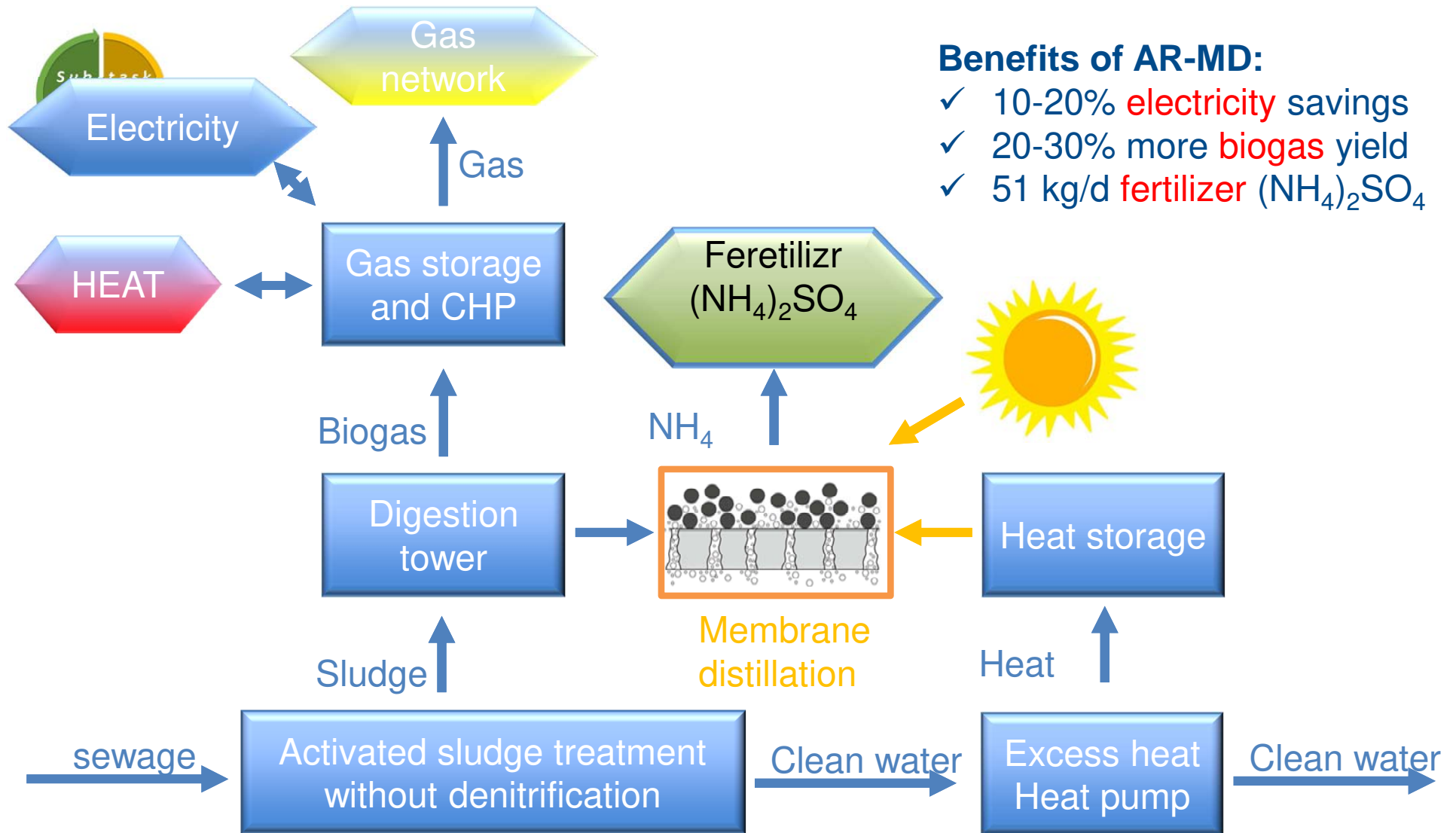
## Subtask C - Examples / Projects



- Wastewater treatment plants (WWTP)
  - Play a decisive role in urban structures
  - Conventional aerobic WWTP is an energy-intensive process
  - 20% of the energy demand of the municipalities is used for waste water treatment
  - Energy generation (biogas) only from a small part of the existing energy content
  - The energy bound in carbon as well as nutrients are destroyed with high electrical energy input.



# Subtask C - Examples / Projects



## Benefits of AR-MD:

- ✓ 10-20% **electricity** savings
- ✓ 20-30% more **biogas** yield
- ✓ 51 kg/d **fertilizer** (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>

# Summary



- Industry and agriculture is the largest water consuming sector AND energy consuming sector (OECD, IEA, 2016) (Eurostat, 2018)
- Change to a sustainable, resource- and energy-efficient industry will be the major challenge

## Results

- Matrix of different industrial separation demands in combination with thermal technologies and availability of low exergy heat sources
- New solar thermal collectors' concepts for industrial water treatment.
- Integration of water decontamination and disinfection technologies driven with solar energy with membrane separation technologies for recovery of nutrients and products/wastes with added value
- Decision making framework/guidelines for stakeholders





# Contact

## Operating Agent

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An aerial photograph of a modern building complex featuring large solar panels on the roof and a prominent yellow and blue logo overlay in the top left corner. The building has a mix of white, grey, and yellow walls, and the solar panels are arranged in a grid pattern. The surrounding area includes a paved courtyard, a road, and some greenery under a clear blue sky.

**AEE INTEC**

**IDEA TO ACTION**

**Thank you  
for your Attention**